

REVISION OF THE GENUS *CALOTIS* R.BR.

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(One hundred and forty-five Text-figures.)

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Synopsis.

Twenty-two species of *Calotis* are redescribed and figured from a large range of material, and four species are reduced to synonymy. Two former varieties have been raised to specific status, but it has not proved necessary to describe any new species.

An introductory section includes a brief historical account of the genus and also a description of the procedure adopted and a discussion of all characters shown by the plants from the point of view of their taxonomic importance. Attention is drawn to the correlation between distribution and the burr-like qualities of the fruits, in support of which certain extra-Australian records are cited.

INTRODUCTION.

Historical.

The first reference to *Calotis* is in the Botanical Register, 6 (1820) 504, the text of which was written by J. Bellinder Ker (alias Ker Gawler) and is as follows: "the character of *Calotis* was formed, but not published, by Mr. Brown, about 15 years ago, from *C. denter*, a species first observed by himself in New Holland, where it is not uncommon in the neighbourhood of Port Jackson. The present (i.e., *C. cuneifolia*) has since been found during an expedition into the interior of the above country, growing on the banks of the river Lachlan, in 1817, by Mr. Allan Cunningham, who is commended by Mr. Brown as 'an indefatigable collector and acute observer'. The generic name has been derived from the two membranous ear-shaped paleae of the seed-crown, which are constant in number and form in the only two certain species yet known, and constitute the most important character of the genus."

The nineteenth century was a period of great activity in the description of new genera and species, as the country was opened up and the collection of specimens became more extensive. Inevitably a number of these names have since been shown to be synonyms. In *Calotis*, as in other genera, with the description of each new species the generic characters were modified accordingly, and the original description of Brown was shown to apply only to the two species he handled. No reflection is implied on this or other pioneer work, since generic characters cannot be recognized as distinct from specific in an unfamiliar group with very limited material. In this instance, Brown considered that the pappus scales "constitute the most important character of the genus" and the significance of the awns was only determined when further material representing other species was collected. It was left to Bentham (1866), in collaboration with Mueller, to collate much independent work and define the genus in its current sense, incorporating in it three other genera, *Huenefeldia*, *Goniopogon* and *Cheiroloma*.

Below (p. 147) is a chronological list of all described species and synonymous genera, discussion of which will be found under the appropriate species headings. Extra-Australian species are included for the sake of completeness.

Distribution.

Apart from two species from Annam (*C. Gaudichaudii* Gagnep and *C. anamitica* Merrill) and one from China (*C. caespitosa* Chang), the genus is confined to the mainland of Australia where it is widespread in inland areas.

Certain species are notorious for their burr-like fruits which, at maturity, are loosely held in the infructescence and become readily attached to passing animals by their barbed awns. These are the species which possess the widest distribution and are found in coastal districts as isolated plants near railway lines, stock routes or stock

Date.	Name.	Type Locality.	Collector.	Current Name.
1820	<i>Calotis dentex</i> R.Br.	Neighbourhood of Port Jackson.	R. Brown.	<i>C. dentex</i> R.Br.
1836	<i>C. cuneifolia</i> R.Br.	Lachlan River.	A. Cunningham.	<i>C. cuneifolia</i> R.Br.
	<i>C. dilatata</i> DC.	Near Peel's Ra., Exley, etc.	A. Cunningham.	<i>C. cuneifolia</i> R.Br.
1837	<i>C. breviseta</i> Benth.	Swan R. and King George's Sound.	F. Bauer.	<i>C. breviseta</i> Benth.
	<i>C. lappulacea</i> Benth.	Swan R. and King George's Sound.	F. Bauer.	<i>C. lappulacea</i> Benth.
	<i>C. microphylla</i> Benth.	Swan R. and King George's Sound.	F. Bauer.	<i>C. ? lappulacea</i> Benth.
1840	<i>Huenefeldia coronopifolia</i> Walp.	New Holland.		<i>C. ? glandulosa</i> F. Muell.
	<i>H. angustifolia</i> Walp.	New Holland.		<i>C. ? erinacea</i> Steetz.
1845	<i>C. erinacea</i> Steetz.	Hay, W.A.	L. Preiss.	<i>C. erinacea</i> Steetz.
1848	<i>C. scapigera</i> Mitch.	Between Sydney and the Gulf of Carpentaria.	T. L. Mitchell.	<i>C. scapigera</i> Mitch.
1851	<i>Goniopogon multicaule</i> Turcz.	W.A.	Drummond.	<i>C. multicaulis</i> (Turcz.) Druce.
1852	<i>Cheiroloma hispidulum</i> F. Muell.	Cudnaka and Crystal Brook.	F. Mueller.	<i>Calotis hispidula</i> F. Muell.
	<i>Calotis cymbacantha</i> F. Muell.	Crystal Brook.	F. Mueller.	<i>C. cymbacantha</i> F. Muell.
	<i>C. Muelleri</i> Sond.	Cudnaka.	F. Mueller.	<i>C. scabiosifolia</i> F. Muell.
	<i>C. polyseta</i> Sond.	Cudnaka.	F. Mueller.	<i>C. lappulacea</i> Benth.
	<i>C. scabiosifolia</i> Sond. et F. Muell.	Wilpena, S.A.	F. Mueller.	<i>C. scabiosifolia</i> Sond. et F. Muell.
1855	<i>C. hispidula</i> F. Muell.	Crystal Brook.	F. Mueller.	<i>C. hispidula</i> F. Muell.
	<i>C. anthemoides</i> F. Muell.	Station Peak.	F. Mueller.	<i>C. anthemoides</i> F. Muell.
	<i>C. glandulosa</i> F. Muell.	Snowy R. near Monaro.	F. Mueller.	<i>C. glandulosa</i> F. Muell.
1859	<i>C. plumulifera</i> F. Muell.	Murray Plains.	F. Mueller.	<i>C. multicaulis</i> (Turcz.) Druce.
	<i>C. tropica</i> F. Muell.	N.W. Australia.	F. Mueller.	<i>C. breviseta</i> Benth.
1861	<i>C. palmata</i> A. Gray.	Hunter R., N.S.W.	A. Gray.	<i>C. cuneifolia</i> R.Br.
1866	<i>C. microcephala</i> Benth.	Murray and Darling Rivers.	F. Mueller.	<i>C. porphyroglossa</i> F. Muell.
	<i>C. porphyroglossa</i> F. Muell.	Cooper's Creek.	Murray.	<i>C. porphyroglossa</i> F. Muell.
	<i>C. pterosperma</i> F. Muell.	Islands of the Gulf of Carpentaria.	R. Brown.	<i>C. breviseta</i> Benth.
1881	<i>C. Kempei</i> F. Muell.	Finke R.	H. Kempe.	<i>C. Kempei</i> F. Muell.
1890	<i>C. latiuscula</i> F. Muell. et Tate.	Finke R.	H. Kempe.	<i>C. latiuscula</i> F. Muell. et Tate.
1901	<i>C. inermis</i> Maiden et Betche.	Urismo, N.S.W.	E. Betche.	<i>C. inermis</i> Maiden et Betche.
1917	<i>C. multicaulis</i> (Turcz.) Druce.	W.A.	Drummond.	<i>C. multicaulis</i> (Turcz.) Druce.
1921	<i>C. anegrocarpa</i> J. M. Black.	Murteree, Strzelecki Creek.	S. A. White.	<i>C. anegrocarpa</i> J. M. Black.
1929	* <i>C. Gaudichaudii</i> Gagnep.	Annam, Tourane.	Gaudichaud.	<i>C. Gaudichaudii</i> Gagnep.
	<i>C. suffruticosa</i> Domin.	Jericho, Q.	Domin.	<i>C. lappulacea</i> Benth.
1930	* <i>C. xanthosoidea</i> Domin.	Jericho, Q.	Domin.	<i>C. xanthosoidea</i> Domin.
	* <i>C. anamitica</i> Merrill.	Tourane, Annam.	O. Kuntze.	<i>C. anamitica</i> Merrill.
1937	* <i>C. caespitosa</i> Chang.	Ngai district, China.	H. Y. Liang.	<i>C. caespitosa</i> Chang.
1946	<i>C. glabrescens</i> C. T. White.	Bybera, Q.	C. T. White.	<i>C. glabrescens</i> C. T. White.
	<i>C. scabriuscula</i> C. T. White.	Chesterton, Q.	S. T. Blake.	<i>C. dentex</i> R.Br.
1952	<i>C. squamigera</i> C. T. White.	Goondiwindi, N.S.W.	C. T. White.	<i>C. squamigera</i> C. T. White.
	<i>C. cuneata</i> (F. Muell. ex Benth.) G. L. Davis.	Rockhampton.	Thozet.	<i>C. cuneata</i> (F. Muell. ex Benth.) G. L. Davis.
	<i>C. brevibradiata</i> (E. H. Ising) G. L. Davis.	Hughes, Nullabor Plains.	E. H. Ising.	<i>C. brevibradiata</i> (E. H. Ising) G. L. Davis.

* These species have not been examined by the present writer.

yards. Cheeseman (1925) recorded *C. lappulacca* from "various ports in the North and South Islands of New Zealand", where it doubtless gained entrance with Australian imports, probably wool. In this connection a specimen of *C. squamigera* from Galashiels, Scotland, is interesting since it is from a collection of alien plants growing in that locality from seed brought in with Australian wool.

It is probable that the wide distribution of some species is a recent development and that prior to the arrival of white settlers and their domestic animals, their ranges were considerably more confined and approximated the present ones of those species whose fruits are not so readily transported.

Economic Importance.

Although most species are highly drought resistant and of good fodder value, the most common are regarded with disfavour by graziers since their burr-like fruits are troublesome in wool. *C. hispidula* is variously described in collectors' notes as "wonderful fodder", "very excellent fodder", "a very bad burr", and "one of the worst pests in the district". Maiden (1920) stated that the burrs of *C. cuneifolia* "greatly injure wool, besides being a source of great irritation to man and domestic animals", while Johnston and Cleland (1943) reported of *C. porphyroglossa*, *C. ancyrocarpa* and *C. multicaulis* that "the awns of the fruits are troublesome to the natives".

Species are referred to in different districts as Daisy Burr, Martagai, Bogan Flea, Bindie, and Bindy Eye.

Nomenclature.

Syntype material of the majority of species and varieties has been examined and lectotypes selected. When this was not possible, the meaning of the name was established by comparison between the original description and the supposed population. "Flora Australiensis" was used extensively in this connection since, as well as the type specimens, Bentham listed a number of others, of which duplicates exist in the National Herbarium, Melbourne, and these have served as a useful basis of comparison in the absence of the type.

Categories.

In general, the principles formulated in an earlier paper (Davis, 1948) have been followed, but intraspecific variation in the size and form of the fruits is wider than in *Brachycome*. This is reflected in the comparatively large number of varieties which have been described at various times. One species in particular, *C. erinacca*, has presented considerable difficulty, but to subdivide it in any way would be to anticipate evolution, since variation is continuous in both fruits and vegetative characters, and the species is best regarded as polytypic.

In only two species has the category "variety" been employed since it implies fixed vegetative variation with a sharp discontinuity separating it from the parent species on vegetative characters.

Specific Descriptions.

All species have been redescribed from specimens loaned for that purpose by the various public herbaria of Australia and a number of private collectors, and in each case the original meaning has been expanded. Where varieties exist, a general description embraces them and is followed by a key in which the parent population is given varietal rank with the specific epithet repeated.

The various measurements in the descriptions serve merely as a guide and have little or no meaning in themselves.

In each case the type locality and collector, as supplied in the original description, is quoted under "type data", and in the case of synonyms referred to in the discussions, this information is provided in brackets immediately following the first mention of the name.

Each description is accompanied by a figure of the habit and camera lucida drawing of the fruit, but where variation is considerable additional figures are provided.

Specimens Examined.

More than 900 specimens are quoted in the text but the number examined was considerably in excess of that figure. The source of each specimen is indicated as in previous papers (Davis, 1948; 1950) with the altered designation of one herbarium and the addition of two others:

State Herbarium, Perth	(P)
New England University College, Armidale	(NE)
Mr. K. Ingram, Mudgee	(KI)

Evaluation of Taxonomic Characters.

In each genus it is necessary to determine which characters are generic, which specific, and which tend to be rather an environmental expression than an indication of affinity. In order to revise a genus satisfactorily a large number of specimens must be examined from a wide geographic range which embraces a variety of climatic and ecological conditions. Ideally, representatives of each species should be grown under varying experimental conditions and statistical analyses carried out in the field. Due to a variety of reasons, however, taxonomists must rely chiefly on herbarium specimens, but despite the handicaps inherent in such a method, a high degree of accuracy can be achieved provided a sufficiently large series of specimens is available.

In a monotypic genus recognition of specific, as distinct from generic, characters is impossible and any attempt to do this, even by analogy with related genera, is little more than wishful thinking. In genera other than monotypic, specific criteria must be clearly established at the outset and adhered to consistently. The practice of describing one species on, say, fruit characters, another on leaf shape and a third on floral details is unsound taxonomic practice.

Characters of a plant which have survival value tend to be influenced by selection in such a way that affinities are obscured, and convergent evolution may lead to morphologically similar structures being shown by species which are not, in fact, closely related. For this reason the description of new species differing in only one character should be avoided, and such existing species should be viewed with suspicion. The most reliable primary taxonomic characters are those of the least survival value since they are not acted on by selection and therefore similarity in these is a reasonable guide to relationship. However, in practice, field determination is based on the indefinable "look" of a plant in which primary taxonomic characters play little or no part, and is based on the unconscious use of secondary taxonomic characters. These are ones which, in themselves, are variable, and alone are of little significance, but of which a certain combination tends to occur in a particular species. It is unfortunate that such a knowledge can only be gained by experience and the written word is of little assistance. It is hoped, however, that the extensive figures in the present paper will, in some measure, meet this need.

Under their respective headings, the various parts of *Calotis* are discussed in relation to their value and reliability in taxonomy.

Habit: This is a secondary taxonomic character whose value depends on the species concerned. For example, the number of scapigerous species of *Calotis* is limited, and the much-branched type of growth quite common, but in a perennial species a young plant may closely resemble, in habit, a fully grown annual. Since the habit is greatly influenced by the environment, care should be taken in comparing plants from different habitats.

Indumentum: The presence of septate hairs is a generic character though the amount of indumentum is variable.

Leaves: In their nature, form and number, leaves are an important secondary taxonomic character, though the effect of the environment on their form must be borne in mind. This is one of the most difficult characters to assess from herbarium specimens as usually no indication is given of the height of the plant. As a result, what are actually the upper leaves of a large plant may be inadvertently compared with the lower leaves of a small one and so lead to an erroneous conclusion since the marked variation